

Remote Diagnosis of the International Space Station utilizing Telemetry Data

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Modern systems such as fly-by-wire aircraft, nuclear power plants, manufacturing facilities, battlefields, etc. are all examples of highly connected network enabled systems. Many of these systems are also mission critical, and need to be monitored round the clock. Such systems typically consist of embedded sensors in networked subsystems that can transmit data to central (or remote) monitoring stations. Moreover, many legacy systems were originally not designed for real-time onboard diagnosis, but are safety critical and would benefit from such a solution. Embedding additional software or hardware in such systems is often considered too intrusive and introduces flight safety and validation concerns. Such systems can be equipped to transmit the sensor data to a remote-processing center for continuous health monitoring.

At Qualtech Systems, we are developing a Remote Diagnosis Server (RDS) that can support multiple simultaneous diagnostic sessions from a variety of remote subsystems. The RDS server is built on a three-tier architecture with a Broker application in the middle layer, and multiple TEAMS-RT based reasoners at the backend. The client layer consists of sensor agents that collect test results and transmit them over a message-passing network. The resultant solution is remarkably efficient. Even an old 50MHz Sparc20 can support tens of concurrent systems involving hundreds of tests. The solution scales easily to hundreds of systems in any modern workgroup server.

One of the goals of the RDS project is to implement a remote health monitoring system based on telemetry data for the International Space station. It, as well as most other NASA space systems, transmits voluminous amounts of sensor data to ground support systems (at NASA-Johnson Space Center, Houston, Texas) for health assessment. This data stream is near real-time, and consists of detailed sensor data from multiple subsystems on board the spacecraft. This presents a unique opportunity. We can demonstrate a real-time remote monitoring solution that utilizes this telemetry data to monitor the health of the various subsystems and we can demonstrate the benefits of an onboard solution, without having to actually install any software on the space station itself!

The International Space Station utilizes a highly redundant, fault tolerant, software configurable, complex, 1553 bus system that links all major sub-systems. All sensor and

monitoring information is communicated using this bus and sent to ground station via telemetry. It is, therefore, a critical system and any failures in the bus system need to be diagnosed promptly. We have, therefore, modeled a representative section of the ISS 1553 bus system using publicly accessible information. In this paper, we present our modeling and analysis results, and our Telediagnosis solution for monitoring and diagnosis of the ISS based on Telemetry data.